Building design for high beam-power facilities

The example of SPIRAL 2

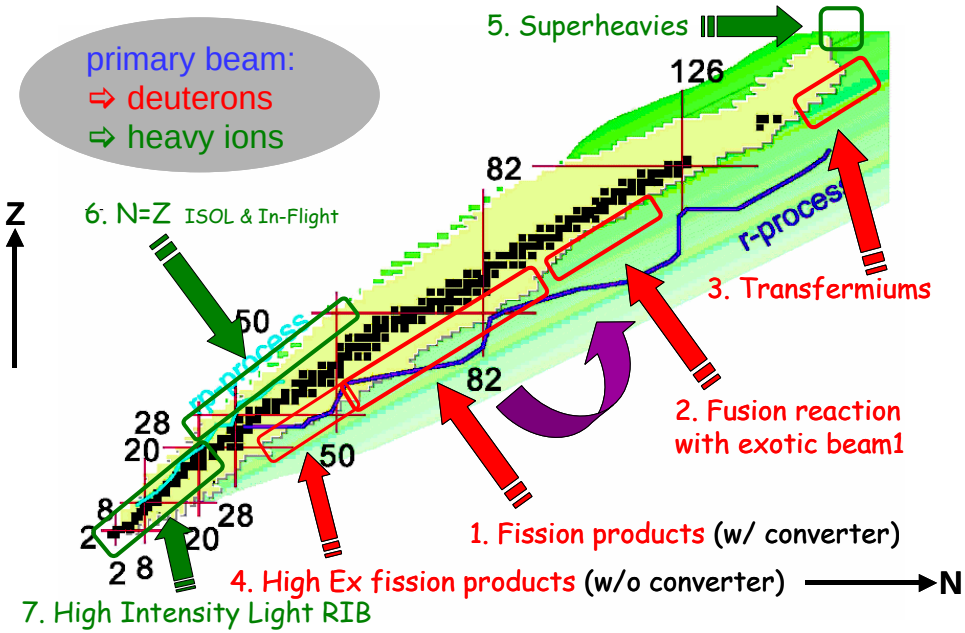
Jean-Michel Lagniel & Lorenzo Roupsard

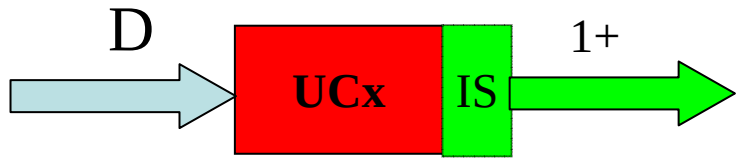
-1- Constraints on high beam-power facilities (RIB production)

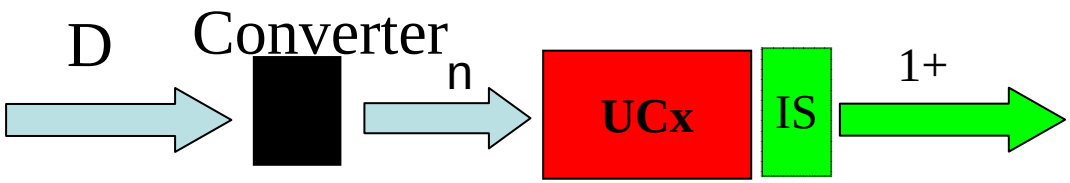
-2- Organization for the building construction

-3- SPIRAL 2 building construction

RIB production / constraints 1/3







Worst case for safety

High beam-power driver **p, d, HI up to 200 kW SPIRAL 2**

Beam losses / beam dump / beam on target ☞ high-energy neutrons + activation

High-intensity radioactive ion beams **10^{14} fissions / s SPIRAL 2**

Big volumes of highly-activated gas ☞ contamination

HBP RIB facilities constraints 2/3

Constraints on the buildings… as usual

Budget - Planning - Manpower

Additional constraints

More radiations + More activation + Contamination

⇓

More shielding **More radiation safety systems**

More access controls **More interlocks** (Important Elements for Security)

Nuclear ventilations **Equipment remote control** (Up to “red” zone)

Infrastructures for waste management

(qualification and preparation system, containers, transport to long term storage)

Activated gas and liquid storages **Seismic resistance**

Stainless steel liner on the walls for easy decontamination…

AND… You have to convince the Safety Authorities…

Organization for the building construction

No architect, no nuclear building engineers in most of the Labs

Building Prime Contractor for the buildings design and construction follow up

As building owner, we have to define our needs in such a way that the BPC

-1- understand (translate accelerator / physicist vocabulary…)

-2- get all the input data at day one to design the building and infrastructures and make a precise cost estimate (20 % → 10%)

Surfaces (m2) **Building organization (connections…)**

Constraints induced by the process

Cooling system performances **Electrical power distribution**

Handling capacities **Ground loads (kg/m²)**

Source terms for radioprotection, gas storages…

Organization for the building construction

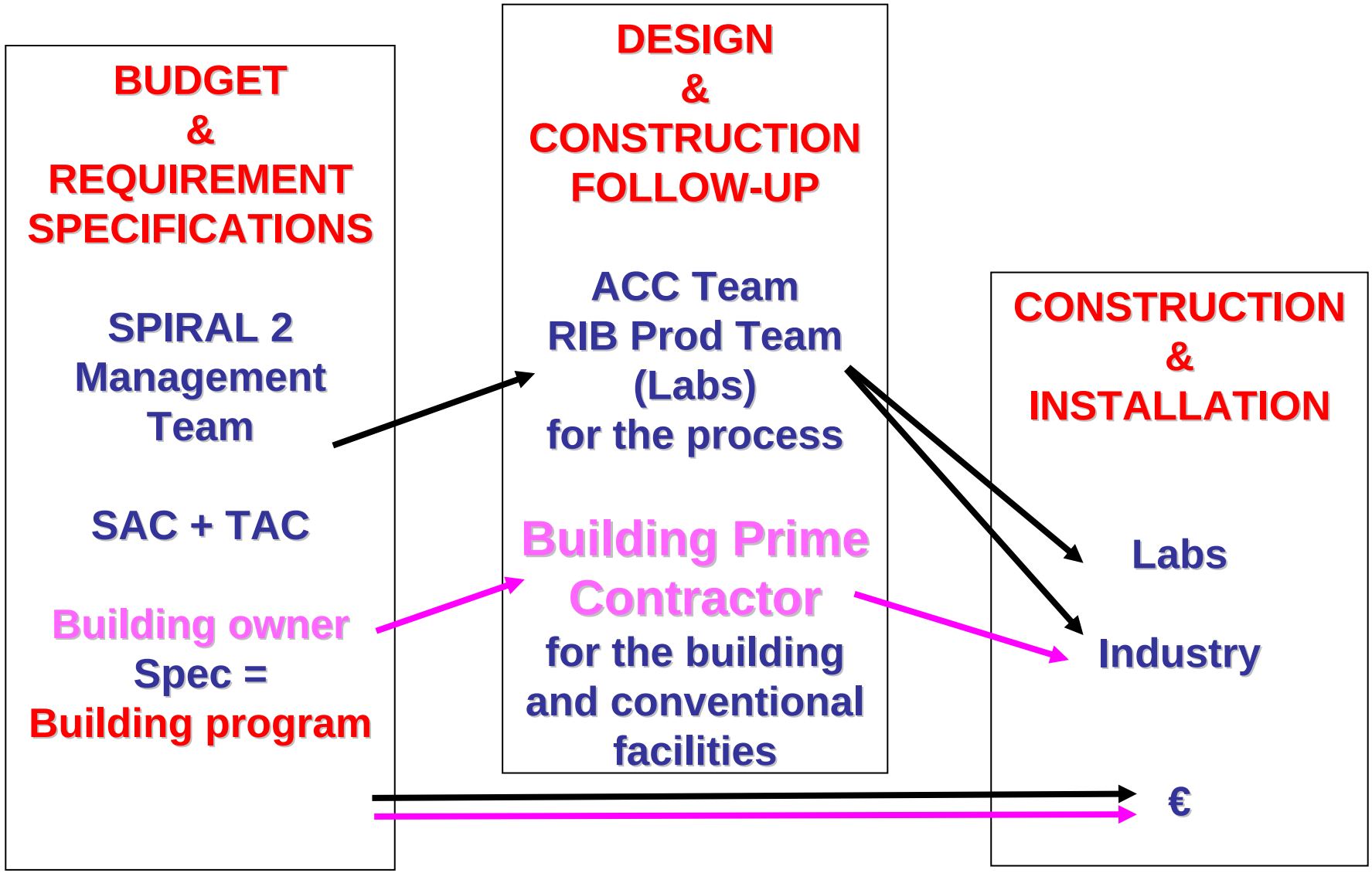
You must know what you want when you sign the BPC contract !
and write the "Building Program"
(contractual specification)

Any modification or additional request will cost you a lot !

Then
you have to organize the cohabitation between the BPC and the "users"
(accelerator people & nuclear physicists)

in such a way that they cannot ask always more !
(cost escalation during the detailed design study)

Organization – Role of the prime contractor



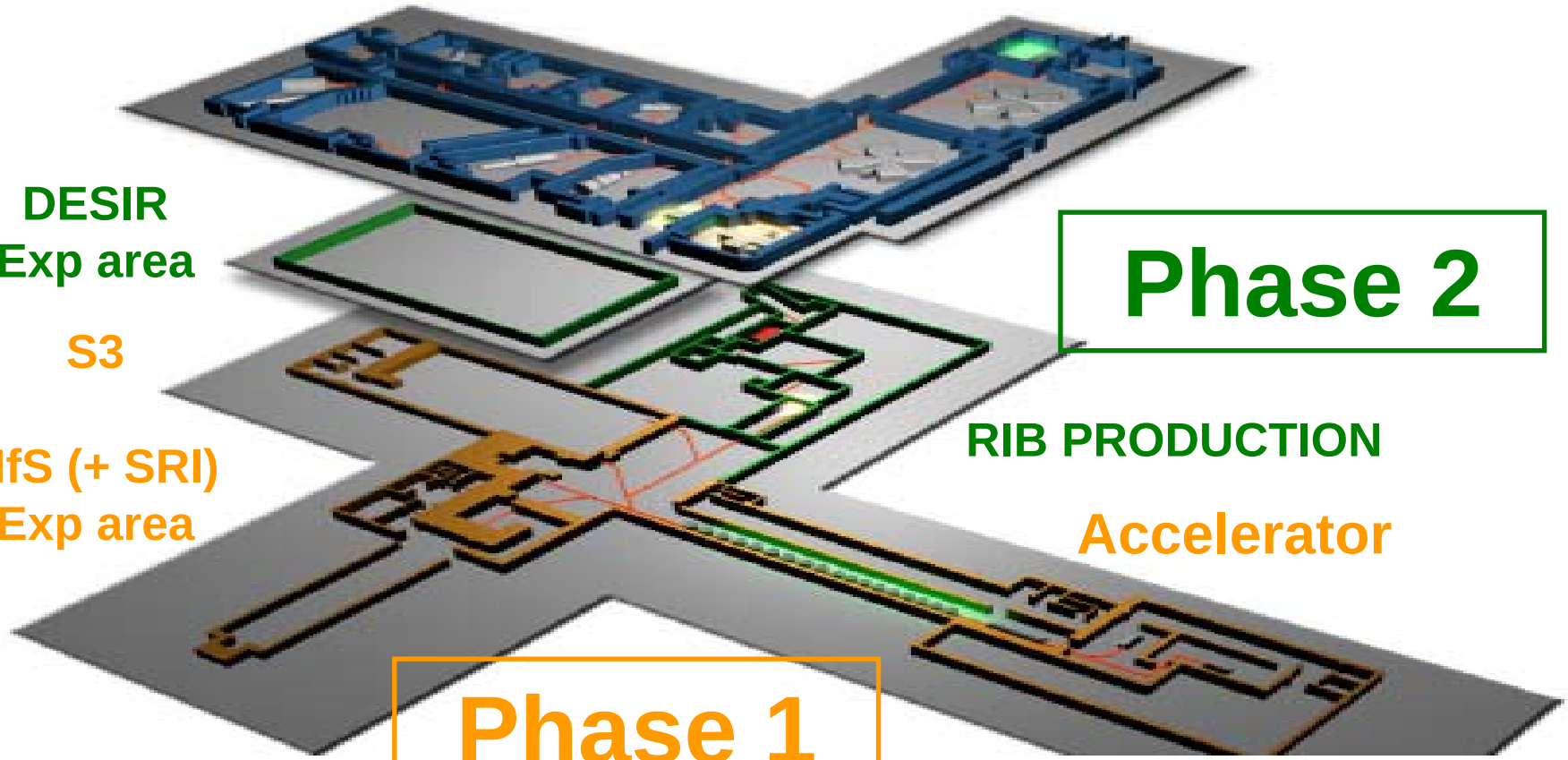
Missions and competencies of the Building Prime Contractor

Taking into account that SPIRAL 2 will be a Nuclear Installation (reactor rules)

- Industrial building structures engineering
(including the nuclear aspects – seismic aspects)
- Architecture (Industrial building)
- Heating – Ventilation – Air conditioning
- Electrical power distribution (20 kV – 380-220 V - ~10 MW)
- Low power networks
- Water cooling system
- Security (including the fire network)
- Nuclear safety (waste…)

Design – Cost optimization – Contract preparation
Construction follow up – Reception
Assistance to the building owner

Existing GANIL facility



+ Annexes = Conventional facilities for Ph 1 & 2

Building Programming (Building owner specs)

Used surface table TOTAL 4457 m2 Used surface

BATIMENT	code secteur	SECTEUR FONCTIONNEL	surfaces utiles
ACCELERATEUR	ACC-1	Sources + LBE	273 m²
	ACC-2	Section RFQ + LME+ Linac	330 m²
	ACC-3	Lignes haute énergie (LHE)	278 m²
	ACC-4	Usine cryogénique	350 m²
	ACC-5	Test – préparation- maintenance	327 m²
	ACC-6	Locaux de logistique	105 m²
	ACC-7	Locaux de servitudes	624 m²
		SURFACE SOUS-TOTAL ACCELERATEUR	**2287 m²**
AEL	AEL-1	Zone NFS	200 m²
	AEL-2	Zone SRI	150 m²
	AEL-3	Servitude NFS-SRI	110m²
	AEL-4	Zone S3	550 m²
	AEL-5	Zone nucléarisé	60 m²
	AEL-6	Servitude S3	200 m²
SURFACE SOUS-TOTAL AEL			**1270 m²**
ANNEXE	ANN-1	Zone de pilotage déporté	125 m²
	ANN-2	Laboratoires et ateliers communs	130 m²
	ANN-3	Système de réfrigération et air comprimé	360 m²
	ANN-4	Distribution électrique	255 m²
	ANN-5	Servitudes du bâtiment annexes	30 m²
SURFACE SOUS-TOTAL ANNEXE			**900 m²**
	TOTAL TRANCHE 1		**4457 m²**

Each building ACC – AEL - ANN described in terms of functional sectors

Each room of the local sectors has been defined in terms of used surface and requirements

Conventional facilities (ANNEXE Bld PHASE 1) designed for PHASE 1 & PHASE 2

Selection of the PH-1 Building Prime Contractor

Nov 16, 2007 : Publication of the “call for candidates”

Feb 5, 2008 : First meeting of the selection committee

Start of the competition between 2 candidates

June 2, 2008 : Reception of the 2 propositions
(building outlines + cost estimates)

June 27, 2008 : Second meeting of the selection committee

2 projects at the same level
→ Start of a competitive dialog with the 2 candidates

Sept 2-3, 2008 : Reception of the 2 projects

Sept 9, 2008 : The SPIRAL 2 Steering Committee select
INGEROP (Engineering) + ATR (nuclear eng – safety) + Nuret (Architect)

Phase One Construction

Phase 1 ground level buildings from the selected Prime Contractor

Phase One Construction

Building optimization : 5 good reasons to choose an underground installation of the process

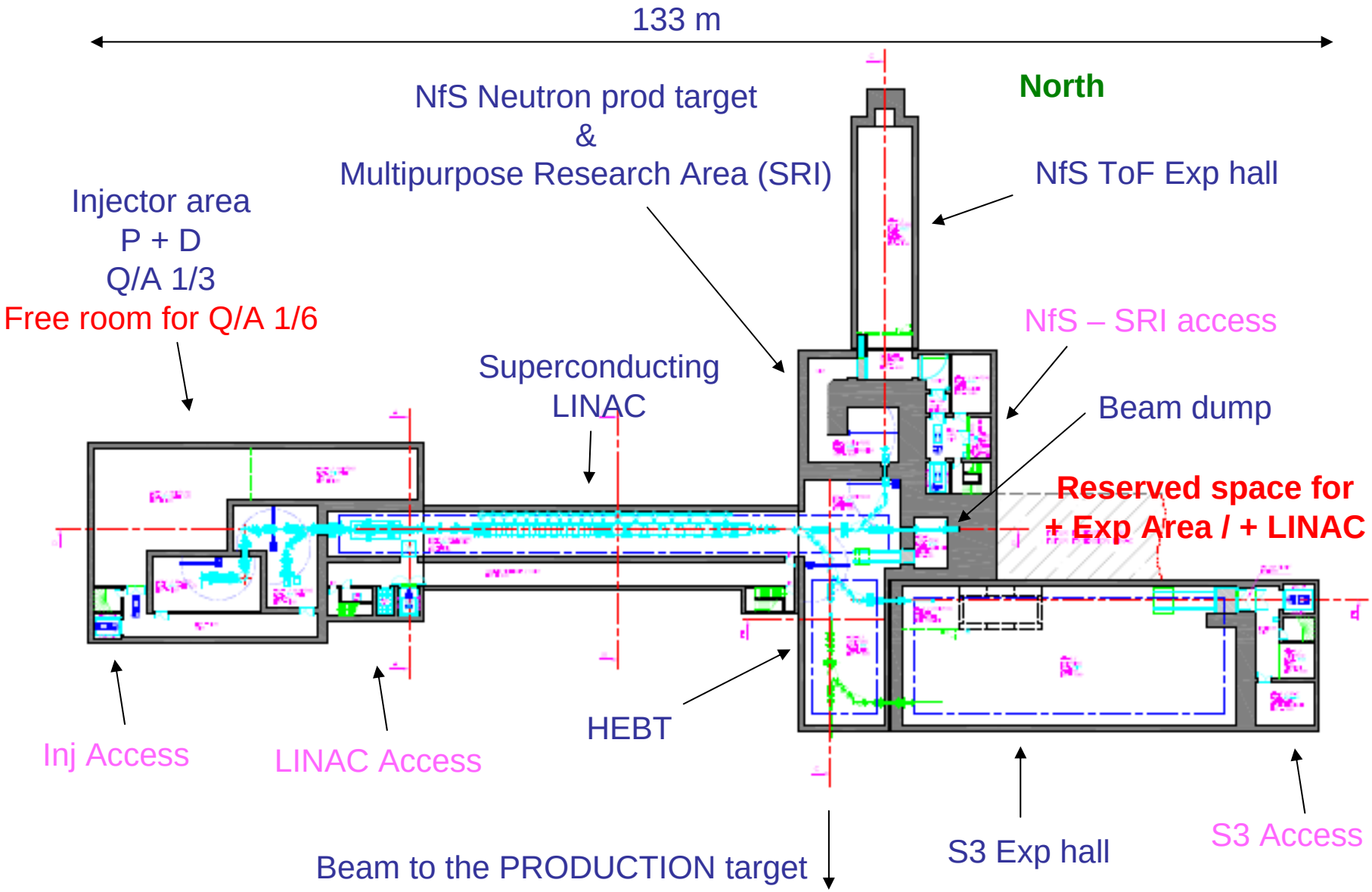
(accelerator, beam transfer lines, LINAC experimental areas, RIB production process)

- ☞ The Epron city construction rules forbid buildings higher than 11 m
- ☞ The GANIL site underground is made up of good solid calcareous stone
- ☞ Less concrete to prevent ground activation than visitor irradiation
- ☞ Better resistance to seism
- ☞ Better resistance to external aggressions
  (Impact of the surrounding buildings, gas-truck explosion…)

☟

Cost saving of the order of 3 - 4 € for the Phase 1 buildings
15 – 20 % of the building structure (shell) cost

Phase 1 - 9.50 m (beam) level

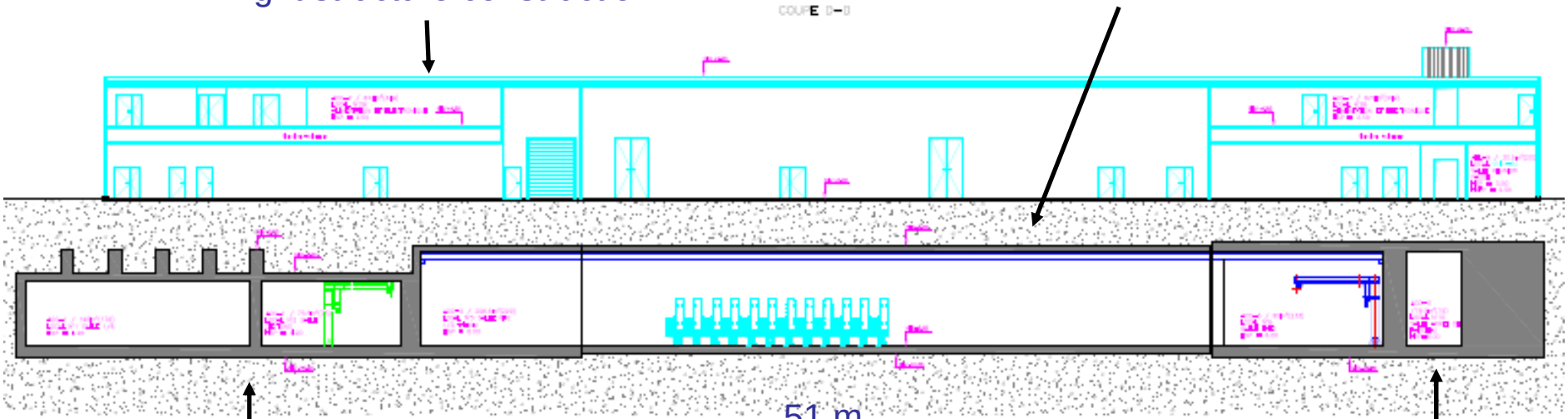


Phase 1 Accelerator building

Cut along the Accelerator tunnel

Surface building with the RF systems,
power supplies, test areas…
Light structure construction

Filling up layer
(most probably using the calcareous
stone extracted during the excavation)



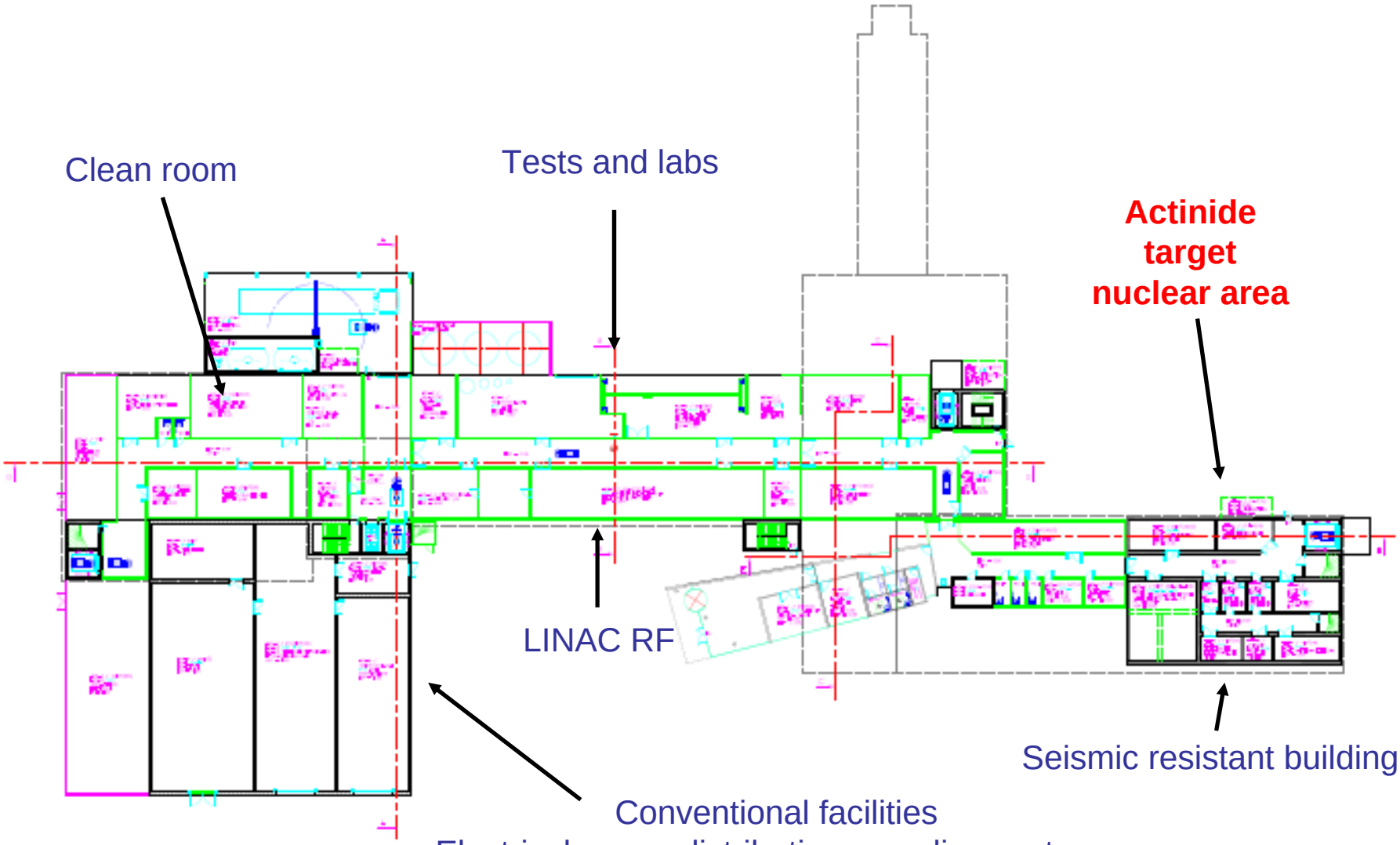
51 m

Injector area

Superconducting
LINAC
6 m high tunnel

Beam dump

Phase 1 Ground level



Phase 1 milestone

End of June 2009 : Building planning permission registration

End of 2009 : First work for the builder's yard installation
First ground breaking (?)

March 2010 : Beginning of the building construction

Mid 2011 : Beginning of the process installation

February 29, 2012 : First Beam

Ground breaking ceremony date not yet known !

Phase Two Construction

Selection of the Building Prime Contractor

Nov 18, 2008 : Publication of the call for candidates

PRODUCTION : Used surface = 3000 m2 Estimated cost = 23 M€
DESIR : Used surface = 2300 m2 Estimated cost = 5.6 M€

March 12, 2009 : First meeting of the selection committee

Competition between 4 candidates

September 4, 2009 : Reception of the 4 propositions
(building outlines + cost estimates)

October 2, 2009 : Second meeting of the selection committee

Nov 2009 : Signature of the PH2 BPC contract

PRODUCTION building

The Phase 2 building prime contractor will have to work

taking into account the detailed design of the process and its close environment done under the supervision of the SPIRAL 2 Team

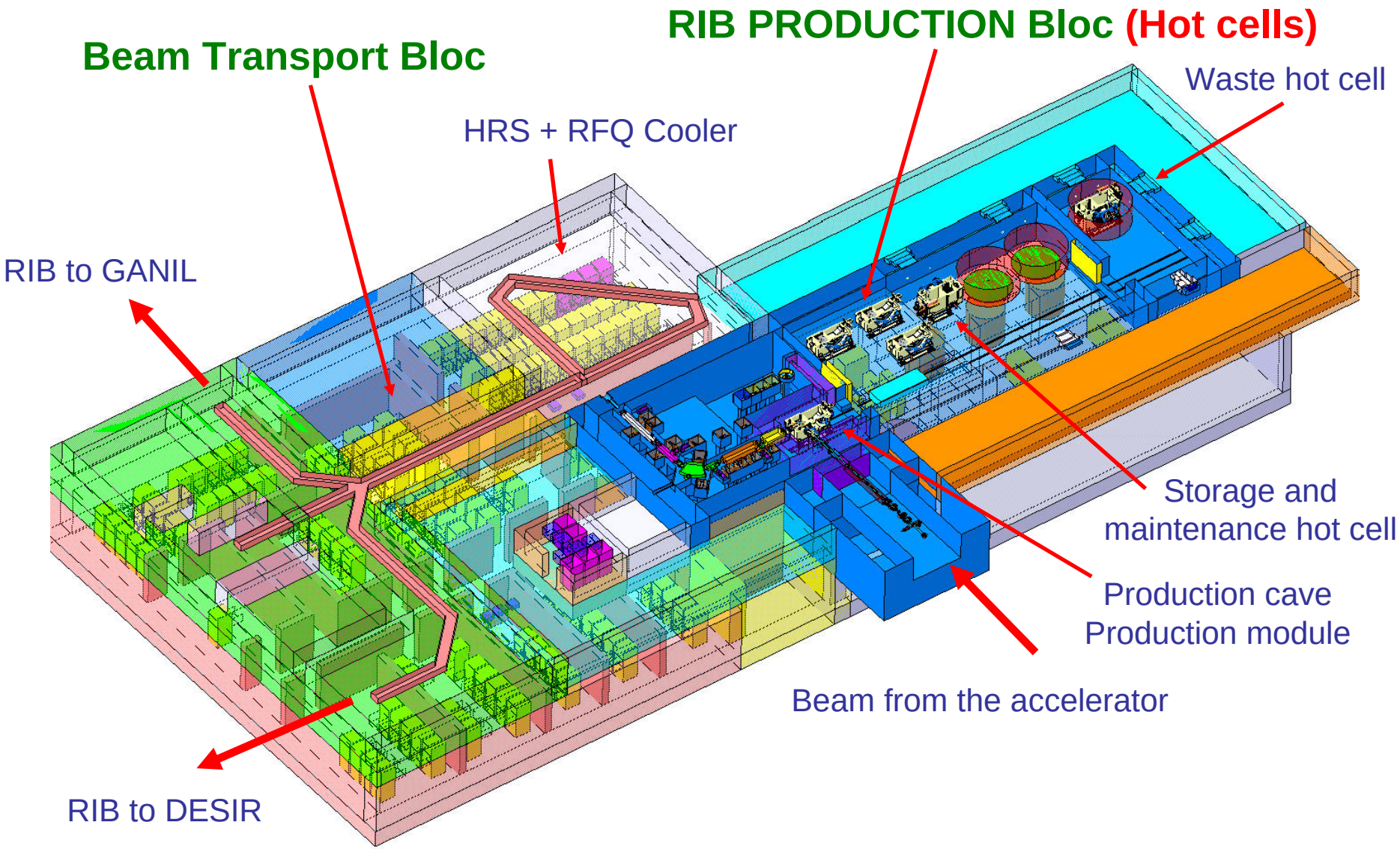
(RIB) PRODUCTION bloc

Target & Source area
+ the nuclear environment

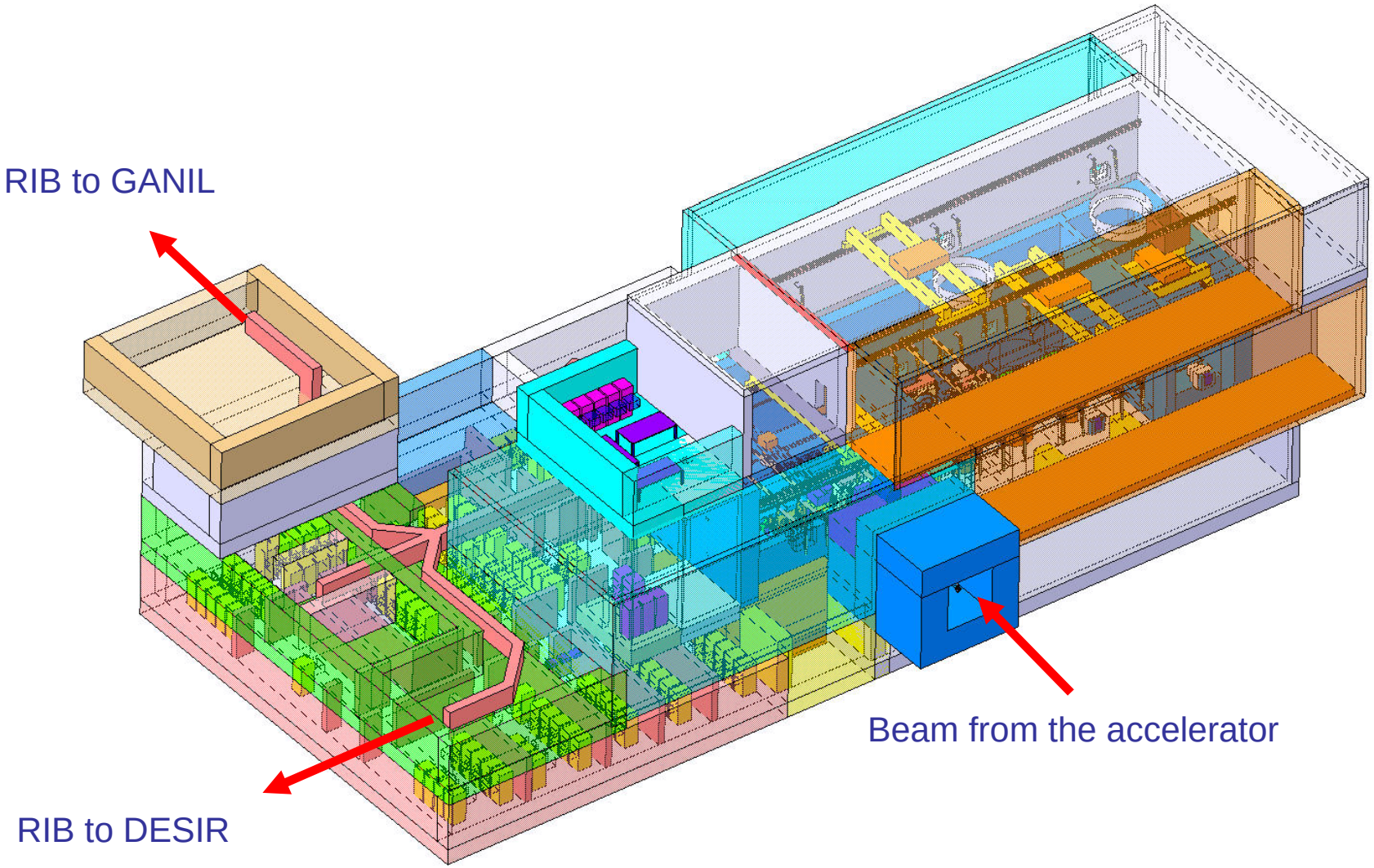
Beam Line bloc

Primary and RI beam lines

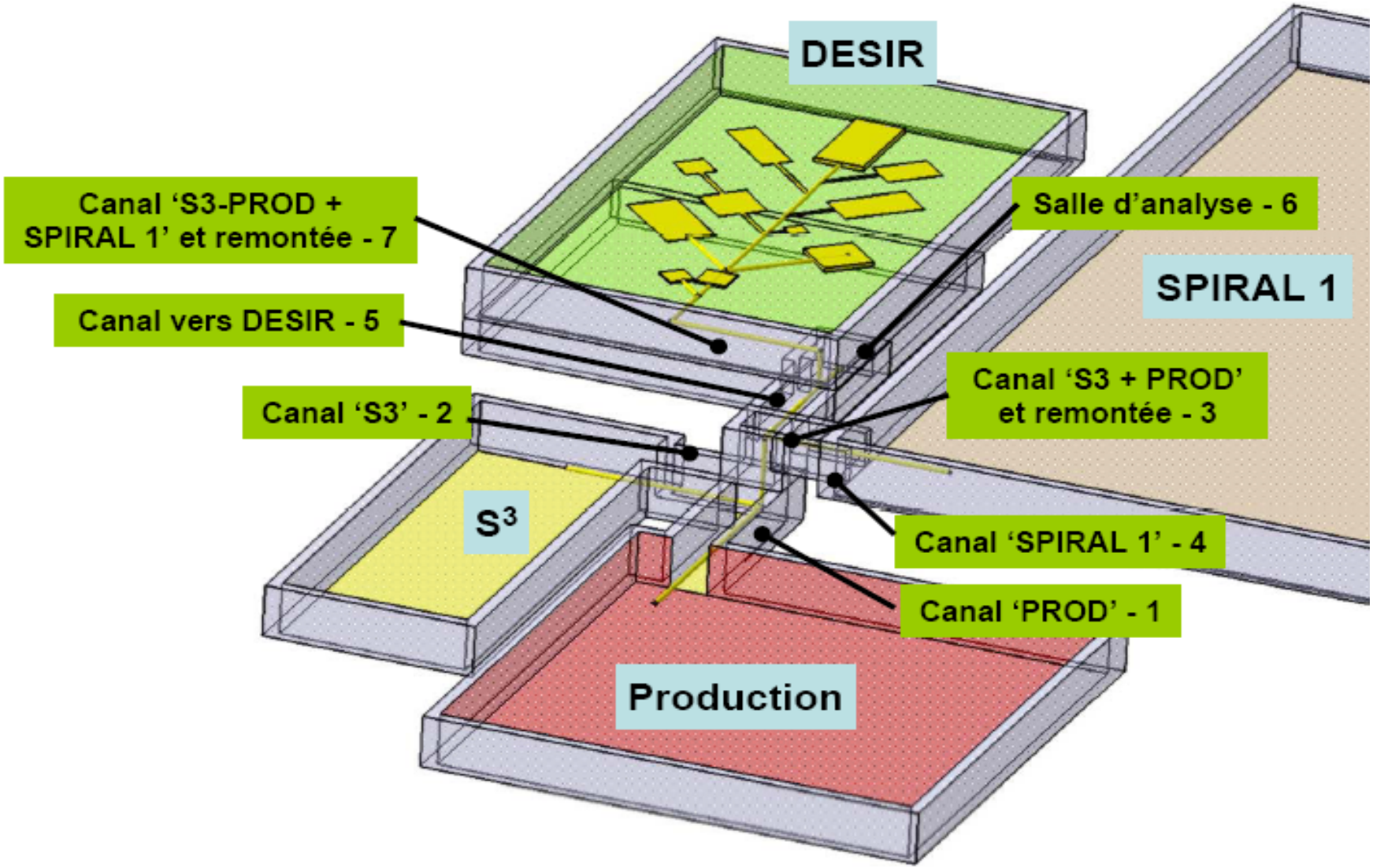
PRODUCTION building



PRODUCTION building



DESIR building



Phase Two milestones

June 2010 : Building planning permission registration (Epron City)

~ Feb 2011 : First work for the builder's yard installation
First ground breaking (?)

Mid 2012 : Beginning of the process installation

Summer 2013 : Tests and validations

November, 2013 : First experiment